

SHARK RESEARCH INSTITUTE NEWSLETTER

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SHORTFIN MAKO SHARK *Isurus oxyrinchus*

Mako sharks occur in all temperate and tropical oceans, and there are two species. The longfin mako, *Isurus paucus*, has very large pectoral fins and large eyes (which indicate that it is a deep-dwelling shark) and most are hooked at 60 to 100 fathoms [360' to 600']. The shortfin mako, however, is common inshore from Cape Cod to Cape Hatteras. Off the New Jersey coast most are caught when surface temperatures are between 50 and 77 degrees Fahrenheit.

This species is a close relative of the great white shark. Although the body shape is similar (both have a conical snout, large first dorsal fin, lunate caudal fin and a strong keel on the caudal peduncle), the mako has a more streamlined body, larger eyes and longer keel than a great white shark. The mako's back is blue, its underside white. Males mature at 1.6 meters [5'2"] precaudal length, females at 2.3 meters [7'5"], and it is thought that the maximum size of this species is about four meters [15'] total length. Reproduction is aplacental viviparous. Litter size ranges from six to ten, and young are born at a length of 70 centimeters [27-28"].

The teeth are heavy, but smooth edged; they are designed to grasp prey swimming in open water, but their prey is not always restricted to smaller creatures which can be swallowed whole. Bigelow and Schroeder (1948) reported an incident in which an 363-kilogram [800-pound] mako shark attacked a broadbill swordfish *Xiphias gladius* off Montauk, Long Island, New York. When the shark

was harpooned it contained about 68-kilograms [150-pounds] of broadbill flesh. Randall (1973) also reported that a 3.2 meter [10'5"] mako shark caught off Caroline Atoll had sections of porpoise in its gut.

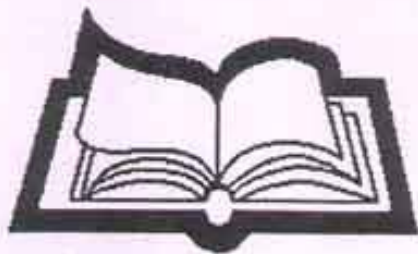
Studies by Chuck Stillwell (1991) indicate that food consumption of sharks is directly related to their rate of growth, rate of digestion and metabolic activity. A warm-bodied shark, this species maintains its muscle temperature above water temperature. Stillwell found that the mako consumes about three percent of its body weight daily and digests an average meal in one and a half to two days; the shark consumes slightly more than ten, possibly as much as fifteen times its own weight in a year. By contrast a slow-growing cold-bodied species such as the sandbar shark may consume only 0.2% to 0.6% of its body weight daily, and take twice as long as the mako shark to digest a meal.

The mako shark does not stalk its prey; it relies on speed and maneuverability to catch the gamefish on which it feeds. Big-game fishermen may see the shark swimming just below the surface, its first dorsal fin slicing the surface as it scans the depths. A hooked mako is a magnificent fighting fish capable of vaulting 20' out of the sea and running at speeds of over 35.5 kilometers per hour.

The shark has attacked boats and has earned a reputation for being aggressive. This summer (July 22, 1992) the *Lady Grace*, a 48' wooden commercial fishing boat out of Ocean City, Maryland, was rammed and swamped by a large mako shark. They were setting pots when the shark, caught on the handline, smashed a 1' X 2' hole in the hull.

This species has also been involved in unprovoked attacks on humans. On September 7,

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New Jersey's Big-Game Fisheries. A Seven Year Summary by Bill Figley. Available from the New Jersey Department of Environmental Protection, Division of Fish, Game and Wildlife.

The publication provides very good data about sharks, billfish, and tuna (distribution, weights, catch efforts and rates, etc.). Copies may be obtained by writing to Marine Fisheries Administration, CN-400, Trenton, New Jersey 08625.

Hunger by William R. Dantz. Published by Tom Doherty Associates, New York, 1992. 348 pp, \$4.99, paperback.

Summer fiction, but well-written and thoroughly entertaining. Genetically engineered giant mako sharks escape from SeaLife Institute's breeding area and roam the Florida Keys in search of tasty tourists and seasoned shark-hunters.

Discovering Sharks edited by Samuel H. Gruber. Published by American Littoral Society, Sandy Hook, Highlands, New Jersey 07732, 122 pp, \$10.00, paperback.

A superb collection of 28 articles on shark biology, behavior and conservation.

Great White Shark by Richard Ellis and John E. McCosker. HarperCollins Publishers, 10 East 53rd St., New York, NY, 270 pp, \$50.00, hardcover.

The first definitive account about the great white shark, this book is a visually stunning and scientifically accurate tour de force. Beautifully illustrated with 28 original paintings by co-author Ellis, the book contains many original photographs by Al Giddings. It is recommended to everyone (scientist and layman alike) who is fascinated by this species. Buy two while they are still available; a copy would make a welcome gift.

From the Cage

Interesting notes about the adventures of SRI Directors and members...

Dr. Maurice Coutts

SRI Board member and underwater videographer Dr. Maurice Coutts has returned from a month-long expedition that took him from the Red Sea to the North Sea.

Maurice reports that Sharm-el-Sheikh, known 20 years ago for its abundance of sharks, was noteworthy for the absence of sharks. Although he saw few

sharks, Maurice spent ten days in Ras Muhammed - Gulf of Aqaba - with Professor Eugenie Clark of the University of Maryland, filming 'Tricky Nicky' and other sand fishes of the Red Sea.

Afterwards, Maurice visited his family in Scotland and spent time with Dr. Monty Priede who utilized a satellite tag to track a basking shark in the North Sea. Maurice also toured the Peterhead fish market which handles the greatest daily tonnage of fish in Europe.

Vincent Capone

SRI board member and President of Marine Search and Survey, Vince was recently Adjunct Professor for Cornell University at Isle of Shoals Marine Lab where he taught a course on marine pollution.

Vince will be in Israel throughout August, instructing the Israeli Navy in the use of side-scan sonar and participate in a mission with them.

Kendrick McMahan

SRI board member and Executive Producer of underwater documentaries (Oceans Productions), is finishing a shoot on NJ's largest and most famous artificial reef, the *Algol*.

Stan Waterman

'The Man Who Loved Sharks,' a documentary about the career of underwater cinematographer Stan Waterman aired in July on The Discovery Channel.

It is a poetic tribute to a fine man - and has some spectacular footage (Stan missed seeing the debut on TV, he was on a shoot in Borneo).

Jeremy Cliff

Jeremy reports that in June 1992 an 892-kilogram [1,966-pound, 8-ounce] great white shark, a mature male, was caught in the Natal Sharks Board net installation at Trafalger. (The great white shark is a protected species in South African waters, but about 50 great whites are caught annually in Natal Sharks Board nets.)

There has been a run of large great whites in Natal Sharks Board nets recently: a 420-kilogram [+925-pound] shark was caught in December 1992, a 440-kilogram [970-pound] shark in April 1992, and earlier in June a 550-kilogram [+1,212-pound] shark was also caught.



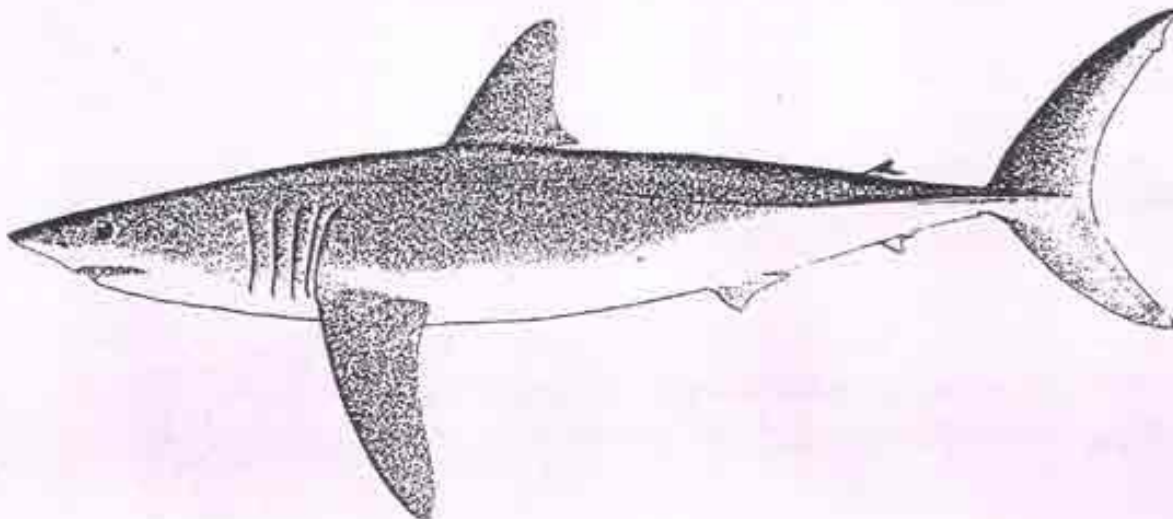
Shortfin Mako

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In 1974 a 20-year-old female, a German medical student, was attacked by a shark in the northern end of the Gulf of Elat in the Red Sea. At 16h30 she was about 380 yards from shore when the shark seized her arm. The behavior of the shark was frenzied; the victim was bitten 12 times before she was rescued. She survived but her left forearm was subsequently amputated. Two days later a 7'6" male shortfin mako shark was caught in the vicinity. Comparison of the bite marks in the victim's thighs with an imprint of the shark's teeth indicated that a mako shark of that size, possibly the same shark, had bitten the girl. The case investigator, Dr. J.E. Randall, noted that the attack occurred during the time that the sea was warmest.

The sea was also very warm on August 8, 1982 when underwater archaeologist and author Sir Robert F. Marx was attacked by a mako shark. The incident took place on Ginger-

bread Reef on the northern edge of Great Bahama Bank, 40 miles from shore. Marx, 6'1" tall and weighing 220 pounds, was wearing a bathing suit, white t-shirt, blue swim fins, and black mask and snorkel. The sea was clear; estimated visibility was 200'. The diver was 100' to 150' from his 20' white-hulled yacht. He had been in the water about an hour and was swimming over a flat sandy bottom in water 25' deep, scanning for evidence of a wreck, when he saw a shark speeding directly at him. The 12' shark struck Marx with such force that he lost his mask. The shark circled and charged repeatedly. Initially Marx was able to fend the shark off, then it bit his right upper arm. After the bite, the shark departed and Marx swam to the boat. On board the yacht another diver used a weight belt to fashion a pressure bandage, and the team hauled anchor for Bimini Island. Six hours after the attack Marx reached Bimini Clinic where his wound was closed with 258 stitches. Two tooth fragments recovered from Marx's arm identified his attacker as a shortfin mako shark.



Sushi? Yes, But Pass Up The Raw Shark!

Readers of SRI's Newsletter know that sharks, skates and rays represent an ancient group of fishes that evolved more than 400 million years ago, a unique class of vertebrates which survived a natural selection process that resulted in fishes now occupying many different aquatic niches. A recent discovery relating to sharks is their relationship to procaryotic microorganisms [organisms whose genetic material is distributed in the cytoplasm; their cells lack a true nucleus]. The procaryotes, commonly referred to as bacteria, are even older than the sharks. Based on their ribosomal ribonucleic acid (RNA) sequence analysis, it is estimated that gram-positive and gram-negative bacteria diverged about 1.2 billion years ago (geologic evidence suggests that photosynthetic bacteria existed 3.5 billion years ago). Clearly, all animals, including sharks, evolved in a world colonized by bacteria. Various survival strategies also evolved, from parasitism to mutualism. Sharks, however, appear to have at least three strategies for coexistence with bacteria, one of which may be mutually beneficial to both shark and bacteria.

In 1982, after the National Aquarium in Baltimore, experienced unusually high morbidity and mortality among display sharks, they provided D. Jay

Grimes with a dead sandbar shark, *C. plumbeus*. Grimes isolated two different bacteria from kidney and liver samples: *Vibrio carchariae* and *Vibrio damsela*. Grimes, together with Dr. Sam Gruber and pathobiologist Dr. Eric May, tried to recreate the vibriosis in healthy captive lemon sharks. Control sharks inoculated only with sterile saline were also found to contain *Vibrio* species. Histopathological examination revealed disease of the spleen and liver, and bacteria were present within fixed macrophages [large amoeba-like cells in the immune systems which ingest and destroy bacteria, damaged body cells, and worn-out red blood cells]. Their observation suggested that the bacteria might be capable of long-term survival in macrophages and prompted research to determine if free-ranging sharks contained vibrios, including potentially pathogenic vibrios, or if the infection was limited to captive sharks.

Fifty healthy free-ranging sharks [eight shark species] were sampled and over 300 bacteria were isolated. The researchers found that healthy sharks contain millions of bacteria in all tissues except blood. Blood is free from aerobic and anaerobic bacteria unless the shark is physiologically stressed. Liver, kidney, spleen, pancreas, and muscle were all found to harbor bacteria at densities from 10^2 to $<10^6$ per gram of sample. Also colonized were skin and mucous membranes. These findings indicate 1) the bacteria

were present in very high numbers, and 2) many of the isolates were potential pathogens capable of causing disease in fish and humans. In short, large numbers of bacteria, some with the ability to cause disease, were living in most tissues in apparent harmony with their shark host; sharks possess an indigenous bacterial community.

Most of the bacteria belonged to the genus *Vibrio*, a large group of gram-negative, marine and estuarine bacteria thought to have a common ancestor more than a million years ago. *Vibrio* species are normal and predominant inhabitants of most estuarine and marine environments, including water, sediment, plants and animals, and several are pathogenic for animals. Other bacteria isolated included *Clostridium* and *Photobacterium* species.

Many [ca. 65%] of the isolates are capable of urea hydrolysis (urea is present in shark tissue at a high [ca. 2%] concentration). Sharks do not appear to have the ability to decompose the urea which they produce for osmoregulation - but indigenous bacteria do - which suggests a symbiotic relationship between the sharks and the bacteria. In short, shark meat spoils quickly because it contains high numbers of autochthonous bacteria.

Most notable among the human pathogenic vibrios is *V. cholerae*, the causative agent in cholera. High antibody titers to *V. cholerae* were found in nurse

sharks, *ginglymostoma cirratum*. No isolations of *V. cholera* were made from any shark sampled, and *V. cholera* is known to inhabit marine and estuarine benthic invertebrates, a primary food source for nurse sharks.

Human pathogenic *Vibrio* species frequently isolated from sharks include *V. alginolyticus*, *V. damsela*, *V. parahaemolyticus*, and *V. vulnificus*. *V. parahaemolyticus* is found in acute gastroenteritis (inflammatory disease of the stomach and intestines, producing diarrhea), and *V. vulnificus* in primary septicemia (a general term to describe an infectious agent in the blood, also referred to as blood poisoning), and all are found in wound infections. Acute gastroenteritis accounts for over 50% of foodborne enteritis in Japan and may be related to the Japanese diet which often includes raw fish and shellfish. Primary septicemia also results from consumption of raw or undercooked fish and shellfish. Eaten raw or undercooked, shark meat contains a readily available source of disease-causing bacteria. And, unlike healthy bony fishes whose flesh does not contain spoilage and disease-causing bacteria, sharks are 'inoculated' at capture and ready to 'self-destruct'.

From D. Jay Grimes. 'Procaroyotes & Chondrichthyans: An Ancient Relationship with Public Health Implications for an Expanding Fishery' *Chondros*, Vol. 2, No. 3.

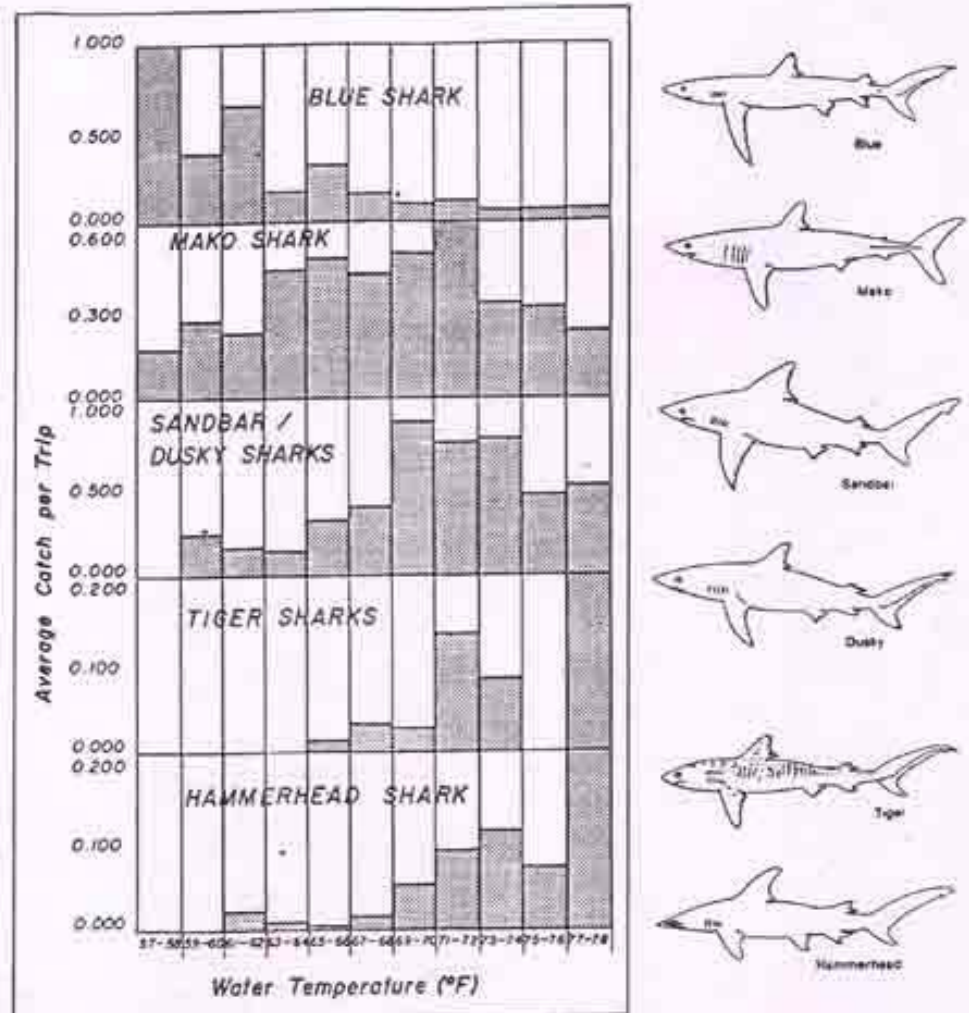
Shark Tagging Report

The American Littoral Society's annual shark/tuna tagging trip took place on July 15, 1992. Eight boats, provided by the Point Pleasant charter Boat Association and the Jersey Coast Shark anglers, left Manasquan Inlet and worked the shark fishing grounds 23 to 30 miles offshore. Although the 1991 trip resulted in three sharks being tagged, along with 40 bluefin tuna ranging in size from 15 to 50 pounds, this year only one shark, a 40 to 80 pound mako, was tagged. Surface temperature was 70 degrees Fahrenheit, and the tuna are late this year, but the sharks have been heavily fished, primarily by longliners.

Q&A

Question: Is it true that some species of sharks can only tolerate a narrow range of water temperature?

Answer: Each species is physiologically adapted to a particular range of water temperature. The chart below, prepared by Bill Figley, indicates surface temperatures in which New Jersey sportsfishermen catch five common species of sharks.



Question: Books have been written about shark attacks, but are there any ballads or poems on the subject?

Answer: Thomas Hood (1799-1845), author of that memorable ditty, 'A Sailor's Apology for Bow-Legs' also composed the following:

SALLY SIMPKIN'S LAMENT

'Oh, what is that comes gliding in,
And quite in middling haste?
It is the picture of my Jones,
And painted to the waist.

'It is not painted to the life,
For where's the trowsers blue?
Oh Jones, my dear! - Oh dear! my Jones,
What is become of you?'

'Oh! Sally dear, it is too true, —
The half that you remark
Is come to say my other half
Is bit off by a shark!

'Oh! Sally, sharks do things by halves
Yet most completely do!
A bite in one place seems enough
But I've been bit in two.

'You know I once was all your own,
But now a shark must share!
But let that pass—for now to you
I'm neither here nor there.

'Alas! death has a strange divorce
Effected in the sea.
It has divided me from you,
And even me from me.

'Don't fear my ghost will walk o' nights
To haunt as people say;
My ghost can't walk, for, oh! my legs
Are many leagues away.

'Lord! think when I am swimming round,
And looking where the boat is
A shark just snaps away a half
Without "a quarter's notice."

One half is here, the other half
Is near Columbia placed:
Oh! Sally, I have got the whole
Atlantic for my waist.

"But now, adieu—a long adieu!
I've solved death's awful riddle,
And would say more, but I am doomed
To break off in the middle.'



Question: Are all sharks 'cold-blooded'?

Answer: No, the body temperatures of great white, porbeagle and mako sharks may be as much as eight degrees Centigrade, possibly even ten degrees, warmer than the surrounding water. In a process called counter-current heat exchange, the heat is retained in the body and the shark maintains a higher body temperature than the surrounding water; belts of arterioles flanked by small veins allow body heat to be recycled. By keeping the temperature of trunk muscles and viscera above ambient, speed and power of muscle contractions and rate of digestion is increased; the warmer body temperature speeds transmission of nerve impulses and increases the power of the muscles - vital assets for predatory sharks in temperate seas.